Coastal Plain Depression Communities

Concept: Coastal Plain Depression Communities are wetlands of relatively small, closed basins in the Coastal Plain, which pond water at least intermittently, and which lack the characteristics of Peatland Pocosins, Natural Lake Communities, and Maritime Wetlands. They occur in Carolina bays, limesink depressions, and a variety of other depressions on geologically young surfaces. Their vegetation is extremely varied, ranging from open water and herbaceous vegetation to shrubland and forest.

Distinguishing Features: Coastal Plain Depression Communities may be distinguished from most other Coastal Plain communities by their occurrence in small, closed basins that hold standing water at least at times. Most basins are distinctive, but the subtle topography of the outer Coastal Plain and the presence of seasonally high water tables and slow runoff from high rainfall events in many flat areas can make some basins difficult to recognize. In addition, excessive soil drainage in sandy areas allows some closed basins to never hold water and not to be wetlands at all. Therefore, the distinctive vegetation of the specific communities often is crucial for recognizing Coastal Plain Depression Communities.

If permanent standing water is present, Coastal Plain Depression Communities are distinguished from Natural Lake Communities by occurring in much smaller basins and having water bodies that are much smaller, lack wave action, and generally are more vegetated. Open water is not more than a couple of acres in size, consistent with the Cowardin et al.'s (1979) definition of palustrine rather than lacustrine wetlands as being less than 20 acres/8 hectares. Maritime Wetlands, which often occur in closed basins, are distinguished by locations on barrier islands, with the concomitant influence of salt spray, geologically younger surfaces, and the dynamic coastal environment. Coastal Plain Depression Communities do not include communities that fit the characteristics of Peatland Pocosins. Where Peatland Pocosins occur in depressions, the depressions are filled with moderate-to-deep organic matter accumulations and the vegetation is indistinguishable from other peatlands. However, the distinction can be subtle in transitional communities such as Small Depression Pocosins and some Coastal Plain Depression Swamps. Coastal Plain Depression Communities are distinguished from various closed basins of active floodplains, such as Oxbow Lakes and some Cypress–Gum Swamps, by the lack of river flooding. Piedmont and Mountain Upland Pools and Depressions are similar basin communities of the inland geologic regions, sometimes sharing species with Coastal Plain Depression Communities but also having distinctive vegetation.

Within the Coastal Plain Depressions theme, the communities are distinguished by the combinations of hydrology and vegetation. Small Depression Pocosins have dense shrubby vegetation, sometimes with an open tree canopy, resembling that of Peatland Pocosins and Streamhead Pocosins, though with some additional species. Coastal Plain Depression Swamps have a substantial tree canopy, generally of *Taxodium ascendens* or *Nyssa biflora*. The Pocosin Subtype may also have a substantial shrub layer, but the Cypress Dome Subtype has deep water and little shrub layer. Cypress Savannas occur in flat basins with substantial differences in water presence from year to year. They generally have an open canopy dominated by *Taxodium ascendens*. In the few treeless examples, floristic differences distinguish them. Wetter depressions

have herbaceous vegetation, but often have a ring of dense shrub and tree vegetation around their edge. This woody edge zone is recognized as the Small Depression Shrub Border community.

Herbaceous Depressions are divided into broad categories by wetness and the vegetation it promotes. Vernal Pools dry early and have facultative wetland plants, sometimes even upland species. Small Depression Drawdown Meadows have longer flooding but still a substantial dry period. They may fill a basin or occur as a broad band in zoned basins. Small Depression Ponds can hold water for much or all of the growing season. The Typic Marsh and Cutgrass Prairie subtypes are shallow enough that they are dominated by emergent large herbs, while the Open Lily Pond Subtype is dominated by floating or submersed herbs. The distinctive Floating Bog community encompasses the rare situations where a thick vegetation mat floating on water creates rooting sites for bog-like vegetation.

Synonyms:

Sites: The most abundant sites for Coastal Plain Depression Communities are Carolina bays without peat (clay-based bays) and limesinks. Limesinks are collapse basins in sandy or loamy sediments believed to result from solution in buried limestone. Other depressions that support these communities include swales in relict inland sand dune systems and relict fluvial features on high river terraces that no longer flood. Limesink depressions often occur in clusters, with basins that vary in depth, steepness, and size occurring close together. Other depressions may also occur in clusters or may be isolated. A given basin may hold one community or may have two or three in an irregular or concentrically zoned complex.

Soils: Most depressions are small and are treated as unnamed inclusions in soil map units. Larger depressions, such as Carolina bays, may be mapped as a variety of wet Ultisols. McColl (Typic Fragiaquult) is often mapped for clay-based Carolina bays. Soils may be an important driver of differences among depression communities or may reflect them. Kirkman, et al. (2000), working in limesink clusters in southwest Georgia, found that what they called cypress savannas were correlated with clay while their marshes were correlated with sand. Denser cypress-gum swamps were correlated with more organic matter in the soil as well as longer hydroperiod.

Hydrology: Coastal Plain Depression Communities are distinguished by at least periods of standing water which cannot run off. Rain falling directly into the basin is a major source of water. Most basins have little or no surface watershed. Many basins are water table windows, with water levels rising and falling with the shallow ground water of adjacent uplands. However, many may also have perched water, with an impermeable layer preventing downward drainage when the surrounding water table falls. Some basins have outlet channels that allow drainage of excess water while retaining water of a certain depth. Water may be removed by infiltration in some cases but solely by evapotranspiration in others.

The hydroperiod – typical duration of flooding – is a crucial characteristic of depressions and is a major driver of the occurrence of the different communities. The centers of the deepest basins may remain flooded except in the most severe droughts. Most basins, however, have both flooded and drawdown periods, holding water in the winter but lacking it at least by late summer.

The variation in hydroperiod is also common and important in these communities. Water levels are sensitive to climatic cycles and to variation in weather from year to year. Some depressions may be flooded throughout some years and dry throughout others. The steepness of the slope in the depression affects the community through its effect on the hydroperiod. Flat-bottomed basins have similar water levels over large areas, and the environment can be strikingly different from year to year. More sloping basins can have greater absolute variation in water level but retain a range of environments, allowing animals and even plants to shift in response.

Vegetation: Vegetation within this theme spans a very wide range of structure and composition, reflecting the range of wetness. In communities with trees, *Taxodium ascendens* or *Nyssa biflora* usually dominate, but *Acer rubrum* var. *trilobum*, *Magnolia virginiana, Persea palustris*, or *Pinus serotina* may occur in Small Depression Pocosin and Small Depression Shrub Border communities. Shrub layers may be similar to pocosins, with *Cyrilla racemiflora, Lyonia lucida*, and *Ilex coriacea* prominent, or may contain *Vaccinium fuscatum, Vaccinium corymbosum*, or, in the case of Small Depression Shrub Border, *Litsea aestivalis*.

Herbaceous composition is even more variable. Vernal Pools often are dominated by species that may be shared with uplands, particularly *Panicum virgatum* and *Andropogon* spp. Small Depression Ponds are most often dominated by *Nymphaea odorata* in the Open Lily Pond Subtype, or by *Hymenachne* (*Panicum*) *hemitomon* or *Leersia hexandra* in the other subtypes, but a variety of other large graminoids may be abundant. Between Vernal Pool and Small Depression Pond in wetness, Small Depression Drawdown Meadows may share species with both and may contain a high diversity of rare plants and of showy herbs such as *Polygala cymosa* and *Lachnanthes caroliniana*. Cypress Savannas too can support a highly diverse herb layer with many rare species. However, more acidic subtypes of several communities have a small set of characteristic herbs shared with pocosins, such as *Anchistea virginica*, *Lorinseria areolata*, and *Sphagnum* spp.

Dynamics: Coastal Plain Depression Communities tend to have a distinctive dynamic character driven by flooding and drawdown and their variations. Intensive study of depressional wetlands at Savanna River Plant and Ichauway Plantation in South Carolina (Mulhouse, et al. 2005, DeSteven and Toner 2004, Kirkman, et al. 2000, Kirkman 1995, Kirkman and Sharitz 1994, Kirkman and Sharitz 1993) has not been repeated in North Carolina but seems to be similar in broad outlines. However, those studies were focused on dominant species and addressed only a few of the species that can be dominant in North Carolina's communities.

Water levels fluctuate over the course of a year, generally being high in the winter and spring and drawing down with the higher temperatures and evapotranspiration in summer. The hydroperiod, the typical duration of flooding, affects the nature of the soil and is the most important driver of community types. Differences in typical water depth also are important and are at least somewhat independent of flooding duration. Some basins have relatively stable water levels while others may go from deep water to dry in many years.

There can be substantial variation from the normal hydroperiod, in response to weather. Stahle's (1988) dendrochronology work showed periods of persistent drought or high rainfall on a time scale of around 30 years. These changes for periods of several years perhaps have more effect on Coastal Plain Depression Communities than on any others. The South Carolina and Georgia

studies documented some of the major changes in vegetation that are possible between wet and dry periods. During extended droughts, upland ruderal species such as *Andropogon virginicus, Eupatorium capillifolium*, and *Pinus taeda* can establish. Species they characterize as fugitive species, such as *Iva microcephala, Croton elliottii, Kellochloa (Panicum) verrucosa*, and *Dichanthelium wrightianum*, appear. In North Carolina, *Cyperus* spp. sometimes are prominent in dried basins. The dominant species of wetter times may remain present at reduced cover or may disappear. Species of open water, such as *Nymphaea odorata* and *Utricularia* spp., may be absent or invisible during drought, while marsh dominants such as *Hymenachne hemitomon* persist but are joined by different species. The characteristic trees species, *Taxodium ascendens* and *Nyssa biflora*, likely only establish during dry periods, presumably resulting in natural populations with several distinct cohorts. These longer-term irregular or cyclic changes are sometimes referred to as disturbances in the literature but they are quite different from other kinds of natural or human disturbances that may occur.

During dry periods, fire appears to be an important part of ecological dynamics. Different Coastal Plain Depression Communities vary, but those dominated by dense herbaceous cover, such as Vernal Pool, Small Depression Drawdown Meadow, and the marsh subtypes of Small Depression Pond can readily carry fire when dry. Even the wetter Open Lily Pond Subtype may burn if its bed becomes occupied by new grass and sedge cover during prolonged drought. The natural surrounding landscape, almost always some kind of longleaf pine community, burned frequently and would have provided ample opportunity for ignition. Thus, the loss of natural fire regimes has potentially altered the depression communities as well as the uplands. Prescribed fires conducted in the winter or confined to wetter growing seasons, when depressions are flooded, do not replace the natural fire regime. The characteristic tree species are at least somewhat tolerant of fire; nevertheless, burning must be an important mediator of their seedling establishment during dry periods.

Many published studies mention *Pinus taeda* establishing during drought, and *Liquidambar styraciflua* and *Acer rubrum* can also be observed invading depressions in North Carolina. Older trees of these species are not found in the less altered, more natural examples of these communities. It is widely believed that these trees should be eliminated when higher water levels return. This has been observed in some limesinks with the return of wetter conditions in 2017 and 2018 after a dry period. However, it appears that fire may be important in preventing the development of dense tree stands during drought. Some other sites have developed dense cover of trees that have become large enough that they may not be easily eliminated. It is often suggested that, once established, increased evapotranspiration by the trees may reduce the hydroperiod even when wet conditions return, and thus they may persist. The long time span of weather fluctuations makes the ultimate outcome unclear. Other alterations besides lack of fire may also be important. The invading tree species have greatly increased in the surrounding landscape with human disturbance, and their seed rain is vastly larger than under more natural conditions. The effects of drainage and ground water pumping in the wider landscape are also unclear but potentially important.

The changes in vegetation over time are driven both by the ecology of individual species and by interactions among them and with other factors. Mulhouse, et al. (2005) found that vegetation changed less in dense marsh vegetation such as *Hymenachne hemitomon* than in the more open *Leersia hexandra* and *Nymphaea odorata* ponds, and they suggested this was because of

competitive effects of the vegetation. However, they noted that these vegetation types were associated with different hydroperiods, with more extreme fluctuation in the more open ponds, making it impossible to disentangle the effects. The ability of *Hymenachne hemitomon, Leersia hexandra,* and *Coelorachis rugosa* to persist is aided by their ability for stem elongation with rising water (Kirkman and Sharitz 1993). *Leersia* elongates the most, but it was found to have less stomatal control and so to be less tolerant of drought. *Hymenache* was found to be dependent on standing dead stems to withstand flooding; it was harmed when stands burned shortly before flooding.

Seed banking is particularly important in these depression communities. It is a particularly beneficial strategy in an environment with such drastic changes. Kirkman and Sharitz (1994) found 72,600 seeds per square meter, with a total of 108 species and 17-19 species per plot. This was double the diversity of standing vegetation in 5x5 meter plots. Most species emerged in standard greenhouse conditions but several species, including rare ones such as *Helanthium tenellum (Echinodorus parvulus*) and *Sagittaria isoetiformis* emerged only with flooding. Perennial species that reproduce in their first year were particularly important. Despite the size of the seed bank for some species, most species had low frequency, and important dominants such as *Leeseria hexandra* and *Hymenachne hemitomon* were not important. These species rely primarily on vegetative reproduction and on persistence of individuals through varying conditions. The longevity of seed banks is not well known. The rediscovery of *Lobelia boykinii*, a rare species of North Carolina depressions, in a Delaware pond after an absence of 100 years, is probably extreme but points at the possibilities.

The longer term dynamics of depressions are necessarily less well known. The few pocosin-dominated, peat-filled Carolina bays that have been studied appear to have once had open vegetation that may have been akin to Coastal Plain Depression Communities. However, given the time spans involved, it is more likely that changes in climate drove the change rather than successional time. Kirkman (1995) notes that some authors have interpreted concentric zonation as representing hydrarch succession, as it is often interpreted in glacial kettle hole lakes. They note that some take the different communities in different depressions to represent successional stages, such as a progression from mineral to organic soils and from herbaceous to woody vegetation. This is possible, but it seems more likely that they represent stable patterns in relative equilibrium with typical hydroperiods and fire regimes. However, it is possible that there are stable states that are rarely created but, once created, persist indefinitely by altering flammability or preventing reproduction of other species.

Carolina bays appear to be stable landforms at present and are probably all around the same age, but limesink depressions in a cluster may form at different times and may change as the underground solution continues. A new pond was formed in the Patsy Pond limesink complex in Croatan National Forest in 2003 and offers a chance to observe the changes first hand. Directional changes that can be expected in limesink depressions include erosion of the sides to create gentler slopes, filling of the bottom by eroded material to make them shallower, accumulation of organic matter or wind-blown clay, and development of a spodic soil horizon. The latter two process would gradually create an impermeable layer that would perch water. Thus ponds might become more independent of water tables over time and hydroperiods shift. The pace of such changes is not known but must be slow. The 2003 new limesink can be seen to have somewhat softened edges

but remains nearly vertical-sided and with only sparse vegetation. The variation in ponds within a cluster may be related to such slow successional processes but is also related to the initial steepness, size, and depth of basins and how they interact with water tables.

Comments: Coastal Plain Depression Communities are some of the most difficult to classify for the purposes of the 4th Approximation, where enduring characteristics are emphasized. The extreme temporal variability in their environmental conditions and vegetation makes it difficult to tell what characteristics are enduring. Observation may be close to impossible in wet years and yet give false impressions if done during drought. All observations need to be interpreted in light of the relationship of current conditions to the long term variation.

Classification also is difficult because of uncertainty about the best spatial scale to use. While some depressions have homogeneous vegetation, in many the vegetation is strongly zoned. Zones may be recognized at a broad range of scales, down to just a couple meters wide. A classification of 1 meter square plots would potentially look very different from a classification of 1/10 hectare plots in the same places. At the same place, a whole-site species list might include many species that would never actually occur close to each other. The 3rd Approximation subsumed the zones, classifying a whole depression as one community based on the wettest or the most predominant portion. The 4th Approximation uses a middle ground approach, distinguishing a small number of communities that can represent broad zones within a single basin. The rationale for this change in approach is that the communities at this scale often are separated. Though a single depression could contain 3 or 4 zonal communities, most do not have that many well developed examples. The best developed, most extensive examples often are in different depressions. Conservation of their diversity is best served if they are tracked separately.

For limesink depressions and other outer Coastal Plain members of this theme, observations and synthesis by Richard LeBlond, contained in Natural Heritage Program reports and personal communications, has been a major contribution to this classification. His work is based on whole-site species lists and specific descriptions of zones and of the role of basin configuration. For Carolina bay depressions, Nifong's (1998) plot-based quantitative study contributes heavily to this classification. His analysis units are 10 meter square plots, but many are extracted from 1/10 hectare Carolina Vegetation Survey (CVS) plots. The sampling spanned a period of many years; the resulting mix of spatial and temporal variation is partially confounded; this is recognized in some places but perhaps not throughout. For these reasons, interpretation for the purpose of the Fourth Approximation is difficult and remains somewhat uncertain. More experience is needed in applying it, and further refinement of the units in this theme is likely. There is a need both for extensive study that compares depressions over a short period of time and for long-term study of the range of variation in single sites.

Coastal Plain Depression communities are better represented in the published literature in South Carolina and Georgia. Though it is difficult to match published names to our classification, much of our understanding of dynamics comes from this area.

References:

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Service. FWS/OBS-79-31.

De Steven, D., and M.M. Toner. 2004. Vegetation of Upper Coastal Plain wetlands: environmental templates and wetland dynamics within a landscape framework. Wetlands 24: 23–42.

Kirkman L.K. 1995. Impacts of fire and hydrological regimes on vegetation of depression wetlands of the southeastern USA. Pages 10-20 In S.I. Cerulean and R.T. Engstrom (Eds). Fire in wetlands: a management perspective. Proceedings of the Tall Timbers Fire Ecology Conference No. 19. Tall Timbers Research Station, Tallahassee, FL.

Kirkman, L.K., R.C. Goebel, L. West, M.B. Drew, and B.J. Palik. 2000. Depressional wetland vegetation types: A question of community development. Wetlands 20: 373-385.

Kirkman, L.K. and R.R. Sharitz. 1993. Growth in controlled water regimes of three grasses common in freshwater wetlands of the southeastern USA. Aquatic Botany 44: 345-359.

Kirkman, L.K., and R.R. Sharitz. 1994. Vegetation disturbance and maintenance of diversity in intermittently flooded Carolina bays in South Carolina. Ecological Applications 41: 177-188.

Mulhouse, J.M., D. De Steven, R.F. Lide, and R.R. Sharitz. 2005. Effects of dominant species on vegetation change in Carolina bay wetlands following a multi-year drought. Journal of the Torrey Botanical Society 132: 411-420.

Nifong, T.D. 1998. An ecosystematic analysis of Carolina bays in the Coastal Plain of North Carolina. Ph.D. Dissertation, University of North Carolina, Chapel Hill.

Stahle, D. W., M. K. Cleaveland, and J. G. Hehr. 1988. North Carolina climate changes reconstructed from tree rings: A.D. 372-1985. Science 240:1517-1519.